# MICROBES IN HUMAN WELFARE

Besides → plank, animals → microscopic → Microbes ⇒ major components of biological systems on this earth.

Microbes present everywhere:
- Soil
- Water
- Air
- Inside our bodies
- Other animals
- Plants

Sites where no other life form could possibly exist:
- Deep inside the geysers → thermal vents (temp - 100°C)
- Deep in soil
- Under the layers of snow several metres thick
- Highly acidic environments

Microbes
- Bacteria
- Many fungi

can be grown on nutritive media & can be seen with naked eyes

* Such cultures useful in → Studies on micro-organisms.

- Microbes — diverse → PROTOZOA, BACT., FUNGI, PLANT VIRUS (Viroids, Prions)
  - microscopic animal

Microbes
- not all pathogen
- causes → large no. of diseases in human beings
  - Diseases in → plants, animals
- but → Several microbes are useful to man in diverse ways



## MICROBES IN HOUSEHOLD PRODUCTS

We use products - derived from microbes - everyday.

Eg. → Milk → LAB (Lactic acid Bact.) OR Lactobacillus → Curd (forms)

When they grow → Produce acids that coagulate & partially digest milk proteins.

contain millions of LAB

Small amt. of curd → as → inoculum OR starter → added to → Fresh milk → at suitable temp → Forms curd

* LAB
- increases → nutritional value of curd by ↑ Vit. $B_{12}$
- In stomach → beneficial role in checking disease causing microbes

DOUGH used for making → Dosa, Idli → is → fermented by bacteria

- puffed appearance due to → production of $CO_2$ gas
- used for making BREAD → Fermented by → BAKER'S YEAST (Saccharomyces cerevisiae)

No. of Traditional drinks & foods → fermented by → microbes

→ TODDY → Traditional drink some part of South India
Made by - Fermenting Palm sap

Microbes used to ferment
- Fish
- Soyabean
- Bamboo shoots

→ To make foods

CHEESE → One of oldest food items in which microbes were used.
- different varities known by their characteristic → taste, texture, flavour → specificity comes from the microbes used

SWISS CHEESE → large holes → due to production of $CO_2$ ← by
Bacterium - Propionibacterium Sharmanii

ROQUEFORT CHEESE → ripened by → Growing specific FUNGI on them → gives Particular flavour



# MICROBES IN INDUSTRIAL PRODUCTS

Production on Industrial scale → requires growing microbes in very large vessel called FERMENTORS.

## 1 FERMENTED BEVERAGES

YEAST specially → used from time immemorial
production of BEVERAGES ← by
Wine, Rum, Brandy, Beer, Whisky

Same yeast → Saccharomyces cerevisiae
used, commonly called brewer's Yeast
for fermenting → malted cereals, Fruit juices → to produce → ETHANOL

① Type of raw material used for fermentation → diff. types of alcoholic drinks are obtained.

② Type of processing → with / without distillation

## 2 ANTIBIOTICS

microbes ← prod by ← ANTIBIOTICS
one of the most significant discoveries of 20th century

Anti → 'against' (greek)
Bio → "life"
"against life" (together)
in context of disease causing organism
With reference to human beings → "pro life"

Antibiotic → chemical substances
Produced by some microbes
to kill / retard growth of other microbes.

out stillation → Wine
→ Beer

☆ Distillation of fermented broth → Whisky
→ Brandy
→ Rum.

## 3 CHEMICAL, ENZYMES & OTHER BIOACTIVE MOLECULES

organic acids, Alcohols, Enzymes → produc. by microbes

- Acid Producers

1) Citric acid – Aspergillus Niger (Fungus)
2) Acetic acid – Acetobacter aceti (a bacterium)
3) Butyric acid – Clostridium Butyli-cum (a bacterium)
4) Lactic acid – Lactobacillus (a bacterium)

Yeast – Saccharomyces cerevisiae → used for production of → Ethanol.

* Microbes are used in prod. of Enzymes

PENICILLIN (antibiotic) → first antibiotic to be discovered
Date
Chance Discovery

Alexander Fleming working on Staphylococci bact.
observed a mould growing in one of his unwashed culture around which staphylococci could not grow
↓ due to
chemical prod. by mould (Penicillium notatum)
→ PENICILLIN (named after the mould)
used extensively to treat american soldiers wounded in world war II.

Full potential as an antibiotic effectively established much later by
① Ernest chain ② Howard Florey
⇒ Awarded noble prize – 1945 for discovery

After penicillin → other antibiotics were also purified from other microbes

Antibiotic helped greatly → improved our capacity to treat deadly disease of
Plague, Whooping Cough → Kali Khansi, Diptheria → Gal ghotu, Leprosy → Kusht Rog
→ used to kill millions all over globe

- Lipase → used for → Detergent formulations → Removes oily stains from laundry
- Pectinases + Proteases → used for → clearing bottled juices (Market bottled juices are dear than home made) due to
- Streptokinase → By streptococcus bacterium → modified by Genetic Engineering → "Clot Busters" → removing clots from B.V of patients who have undergone myocardial infarction or heart attack leading to
- Bioactive Molecule → Cyclosporin A → By fungi Tolypocladium inflatum Gams
↳ Immunosuppressive agent in organ transplant patients

• Statins → produced by Yeast → Monascus Purpureus

commercialised Blood cholesterol lowering agents

acts competitively (inhibiting) → enzyme responsible for synthesis of cholesterol.

# MICROBES IN SEWAGE TREATMENT

Large quantities of waste water are generally generated everyday in city towns → major component of this waste water → Human Excreta.

★ Municipal waste water called → SEWAGE contains large amt. of organic matter + microbes (many of which pathogenic)

★ Sewage can't be disposed off directly into → water bodies (Streams, River)

Before disposal → treated in STPs (Sewage Treatment plants) → To make sewage less polluting



Treatment of waste water done by → Microbes naturally present in sewage

2 stages

**Primary Treatment**

involves physical removal of particles

large → Filtration (Ist) → Floating debris removed

small → through Sedimentation (IInd) → grit → Soil, Small pebbles

★ All solids that settle form the → primary sludge

★ Supernatant forms → effluent → taken for → Secondary Treatment

**Secondary / Biological treatment**

Primary effluent passed to → Large aeration tanks where it is

Constantly agitated mechanically & air is pumped into it. → this allows → Growth of useful aerobic bacteria into FLOCS (masses of bact. + fungal filaments to form mesh like structure.)

while growing these microbes consume → Major part of organic matter in effluent.

this → Significantly reduces BOD (biochem. oxygen demand) of effluent → sewage water treated till → BOD is reduced.

BOD → Amt. of $O_2$ that would be consumed if all the organic matter in 1 L is oxidised by bacteria.

BOD ∝ polluting potential

BOD test —measures→ Rate of uptake of $O_2$ by micro-organisms in a sample of water, & thus

BOD - indirect measure of organic matter present in water.

Once BOD of sewage water is reduced significantly.

the effluent passed to → Settling tanks → where → Bacterial flocs are allowed to sediment

Activated sludge ← this sediment is called

A small part of it ← Pumped back to its aeration tanks → to serve as → Inoculum

remaining (major) part pumped to → Large tanks Anaerobic Sludge Digesters → here → Other kinds of bacteria grow anaerobically

Bacteria produce a mixture of gases ← during this digestion [ in sludge { Bacteria, Fungi } ↔ digest ]

$H_2S$, $CH_4$, $CO_2$ → form → BIOGAS → source of energy → both are inflammable

The effluent from Secondary Treatment plants → released into → Natural Water Bodies → Streams, Rivers



★ Till Date → no man-made technology has been able to rival the microbial treatment of sewage

★ Quantity of sewage is large (due to ↑ urbanisation) > No. of sewage treatment plants

↓↓ hence

◉ Untreated sewage is often discharged directly into rivers leading to their pollution & ↑ in water borne disease

★ Ministry of Environment & Forests has initiated → Ganga Action plan, Yamuna Action plan

To save these major rivers of our country from pollution.

Under these plans ↓proposed to build a large no of sewage treatment plants so that only treated sewage is discharged into river

Methanogens produce biogas while degrading plant waste

# MICROBES IN PROD. OF BIOGAS

Biogas → mixture of gases
→ predominantly $CH_4$
→ Produced by microbial activity
may be used as fuel

Microbes → produce → Diff. type of Gaseous end products during → Growth, Metabolism

Certain Bact: grow anaerobically → prod. large amt. of $CH_4$ along with $CO_2$, $H_2$

① microbe used
② Organic subs. they utilize
depends on → Type of gas produced

collectively called → METHANOGENS → one common bacterium → Methanobacterium

also present in → Rumen (a part of stomach) of cattle → has a lot of cellulosic material present in food of cattle is present. these bact. → Breakdown cellulose & play imp. role in nutrition.

commonly found in → Anaerobic Sludge (during sewage treatment)



Humans — not able to digest cellulose bcz → No cellulase present.

Excreta of cattle → dung commonly called Gobar → rich in bacteria (methanogens)
used for generation of
Gobar Gas commonly called Biogas

## Biogas Plant consists of

① Concrete tank → 10-15 ft deep → bio waste collected → slurry of dung fed
② Floating Cover → placed over slurry → Keeps on rising as gas is prod. due to microbial activity in tank.
③ Outlet → connected to pipe to supply biogas to nearby houses.

* Spent slurry removed through Another outlet → may be used as FERTILISER.

* Cattle dung → more available in (Rural areas) (large quantity) → cattles here are used for variety of purpose
Biogas plants are more → hence after built here.

* Biogas prod. used for → cooking, lightening

* Technology of Biogas production was developed in INDIA due to efforts of

IARI — Indian Agricultural Research Institute

KVIC — Khadi & Village Industries Commission



# MICROBES AS BIOCONTROL AGENTS

Biocontrol refers to → Use of Biological agents for controlling plant diseases, Pests

* In modern society these problems tackled by ↑ use of chemicals

Pesticides, Insecticides

① toxic
② harmful
to → human beings, animals alike

Pesticides → harms crop plants; harms fruits, vegetables

Insecticides → polluting Environment → soil, water, ground

also polluted by use of weedicide to remove weeds.

## Biological Control of → Pests, Diseases

In Agriculture → there is method of controlling pests that relies on → Natural Predation (rather than introducing chemicals)

* Key belief of farmer → Biodiversity furthers Health.
* More variety a landscape has, more sustainable it is.

Organic farmer works to create a → System where → Insects that are called pests sometimes are not eradicated.

but instead → Kept at manageable levels by complex system of ~~checks~~ balances within a living & vibrant ecosystem.

contrary to "conventional" farming practise → where chemicals are used to kill both useful, harmful forms indiscriminately

Not good.

Bioconfrol → holistic Approach that seeks → to develop understanding of webs of interaction b/w myriad of organisms constituting field flora, Fauna

Organic farmers holds view → eradication of creatures that are often described as pests is not possible, but also undesirable

for without them → Beneficial predators, parasites insects which depend on them for → food, hosts → would not be able to survive

Use of Bioconfrol measures will greatly reduce dependence on toxic chemicals & pesticides

Imp. part of Biological farming approch is become familiar with various life forms that → inhabit field predators and pests, their life cycle, patterns of feeding, habitats they prefer

this will develop appropriate means of biocontrol.

Ladybirds & Dragonflies control/rid of Aphids

Dragonflies control/rid of mosquitoes

bacteria → available as in sachets as dried spores → mixed with water → sprayed on vulnerable plants → Brassica, Fruit trees → eaten by insects larvae → in gut of larvae toxin released & larvae gets killed

Bacillus Thuringiensis → control Butterfly caterpillars

Bact. disease will kill the caterpillars, but leave other insects unharmed.

Bcz. of development of methods of Genetic Engineering in the last decade or so, the scientists have introduced B. thuringiensis toxic genes into plants.

Such plants ⟶ Resistant to attack by insect pests (Bt. cotton example.)

fungus Trichoderma (free living)
- very common in Root ecosystem
- Effective biocontrol agents of several plant pathogens.

Baculoviruses → are pathogens
- Attack insects & other arthropods
- Genus: Nucleopolyhedrovirus → excellent candidates for
  - Narrow spectrum insecticidal applications ①
  - species specific ③
  - no -ve impacts on: Plants, Mammals, Birds, Fish, Non target insects
  - desirable when
    1. Beneficial insects are being conserved to aid in an overall Integrated Pest management (IPM)
    2. OR, when ecologically sensitive are to be treated

# MICROBES AS BIOFERTILISERS



Organic farming ← Use of Biofertilizers.
- are organisms that enrich nutrient quality of soil
- main source
  - Bacteria
  - Fungi
  - Cyanobacteria

* Roots of leguminous plants — formed by → Symbiotic association of Rhizobium
  - fix atm. nitrogen into organic forms
  - Nutrient ← used by plant as

- Bact that fix atm $N_2$ → free living in soil → Azospirillum, Azotobacter → thus enriching nitrogen content of soil.

- Mycorrhiza (Symbiotic) (Mutualism) → Many members of Genus – Glomus form mycorrhiza
  - Fungal symbiont → absorbs P from soil to plant
  - Other benefits
    - Resistance to root borne pathogens
    - tolerance to → Salinity, Drought
    - overall ↑ in plant → growth → development.

- Cyanobacteria → autotrophic microbes → widely distributed in → aquatic, terrestrial environment
  - Many can fix atm. $N_2$ → Anabaena, Nostoc, Oscillatoria

In Paddy field. → Cyanobacteria – Imp. biofertilizer.

BGA adds → Organic matter to soil → ↑ fertility

Currently – In our country → a number of biofertilizers are available ~~commercially~~ in market → Farmers use these regularly in their fields
- → To replenish soil nutrients
- → Reduce dependence on chemical fertilizers